THE IMPACT OF A LOS ANGELES COUNTY STATIONARY LEAD SOURCE ON THE BLOOD LEAD LEVELS OF CHILDREN LIVING NEARBY

FINAL REPORT

BY

Amy Rock Wohl, Ph.D.
Principal Investigator
Toxics Epidemiology Program
Los Angeles County Department of Health Services
2615 South Grand Avenue - Rm. 502
Los Angeles, CA 90007

SUBMITTED TO:

Ms. Christine Brenk
South Coast Air Quality Management District
21865 Copley Drive
Diamond Bar, CA 91765

Jo Ann Semones, Ph.D.
Air and Toxics Division
U.S. Environmental Protection Agency
Region IX
75 Hawthorne Street
San Francisco, CA 94105-3901

February 28, 1994

TABLE OF CONTENTS

APPENDIX D

PROCEDURE FOR COLLECTION OF INDOOR PAINT SAMPLES

The EHT looked for visibly peeling or flaking paint on window sills, woodwork, doorways, stairs or walls in the child or children's major play area. The EHT identified two areas in the child's play area to sample for paint. Only one sample was taken from each source.

After identifying the sampling site, the EHT used a clean pen knife to scrape off approximately a 1 centimeter square area of peeling and/or chipping paint chips. The EHT made sure to sample all layers of the paint. Alternatively, the EHT put on gloves and used his or her hands to peel or pull off pieces of paint. The paint chip was placed in a plastic whirlpak.

The EHT labeled the sample whirlpak with the location that the sample was taken from, the household identification number, the date and the initials of the EHT.

After taking each sample, the EHT cleaned the pen knife with an alcohol swab and threw away the sampling gloves. The paint samples were submitted for lead analysis on a weekly basis to a private contract laboratory.

In 5% of the homes, a quality control sample of paint was collected alongside each paint sample and was sent to EHL in Berkeley, California for analysis. The results of the dual analysis were used to assess the reliability of the results of the contract laboratory's analyses.

the gauze pad, the EHT thoroughly wiped out the filter holder with each gauze pad until no visible dust remained. The gauze pads were placed in the petri dish with the filter.

The petri dish was labeled with the household identification number, the location of the collection, the date of the collection and the EHT's initials. In every tenth house, a field blank was collected. After dust sampling, the EHT merely put the filter into the cassette in the vacuum cleaner, removed the filter, and wiped the barrel of the cassette with the gauze pads. All field blanks were also labeled with the household identification number, the location of the collection, and the date of collection. The tops of the petri dishes were sealed with tape so that the top was secure. The dust sample and field blanks were placed in ziplock bags and stored right side up. The petri dishes were packaged and mailed to AIHL for analysis.

TABLE OF CONTENTS (Continued)

1. SUMMARY

The aim of this study was to examine the association between the ambient air and soil lead levels surrounding a large stationary lead source in Los Angeles County and the blood lead levels of the children living nearby. A cross-sectional study design was used in which two communities were identified: the potentially exposed community of Hacienda Heights, California, located downwind of a secondary lead smelter (Site 1) in the City of Industry; and the control community of West Covina, California, a community without a lead smelter.

Biological and environmental samples were collected from November, 1992 to July, 1993. The data collected included venous blood samples from 122 children, ages 1-5 in each of the two communities, and soil, paint and housedust samples from approximately 100 households in each of the two communities.

Results indicate that the geometric mean of the soil lead measurements from the backyard, frontyard and the side of each of the homes were higher in the exposed community than in the control community. The geometric mean of the soil sample obtained from the area around the path leading to the homes was no different in the two communities. A summary measure of outdoor soil unaffected by outdoor housepaint was also evaluated, and the geometric mean of the summary soil measurement was higher in Hacienda Heights than West Covina. The geometric mean of the summary soil measurement was 107 parts per million (ppm) in Hacienda Heights, and 82 ppm in West Covina (T-statistic=3.2; p-value=0.002). Outdoor paint lead levels were also higher in Hacienda Heights than West Covina (Geometric Mean, Hacienda Heights = 1773 ppm; Geometric Mean, West Covina = 1313 ppm; T-statistic=2.3; p-value=0.002).

The U.S. Centers for Disease Control (CDC, 1991) considers blood lead levels less than 10 micrograms per deciliter (ug/dl) to be acceptable for young children. The geometric mean of the blood lead measurements in Hacienda Heights and West Covina were both below the limit of detection (less than 5 ug/dl). There was no difference between these two means (T-statistic=1.8; p-value=0.07). There were more children in Hacienda Heights than West Covina with a blood lead level between 5 and 9 ug/dl (Chi-square test statistic=5.5; p-value=0.02) when

compared to those with a blood lead level less than 5 ug/dl, the limit of detection.

In conclusion, soil lead levels are slightly higher in the residential community near Site 1, however, the lead in the soil is not associated with elevations in blood lead levels in the young children living near the secondary smelter. The blood lead levels of the children living near the smelter are normal and are minimally different from the blood lead results observed in the young children living in a similar community without a large stationary lead source. The outdoor paint lead levels are higher in the exposed community near the lead smelter. However, this difference is not associated with detectable differences in blood lead levels.

2. INTRODUCTION AND BACKGROUND

Emissions from stationary lead facilities have the potential to contribute to the overall lead burden of young children living in close proximity to such sources (Landrigan, 1975; Levallois, 1991; Roberts, 1974; Roels, 1980). Levels of lead in ambient air greater than 2 micrograms per meter cubed (ug/m^3) as a monthly average and soil levels in excess of 1000 ppm have been shown to be associated with elevated blood lead levels in children (Yankel, 1977). Excessive absorption of lead in young children has been shown to result in developmental impairment and long-term damage to the central nervous system (Benevich, 1990; Lin-Fu, 1972). The precise magnitude of these contributions has not been well-characterized to date in populations residing near lead facilities in Southern California.

The objective of this study was to examine the association between ambient air and soil lead levels surrounding a large stationary lead source in Los Angeles County and the blood lead levels of the children that live in close proximity to the lead source. Young children living near the stationary lead source were the focus of this study as they are most vulnerable to the effects of lead (CDC, 1991). Young children play outside in potentially lead-contaminated soil and have hand-to-mouth behavior which enhances their ability to become exposed when they put their hands covered with dust or dirt containing lead into their mouths. Once exposed, young children absorb more ingested lead into their system than do adults. In addition, the developing neurological systems of young children are more susceptible to the neurotoxic properties of lead compared to the neurological systems of adults.

The results of this study will be used to further illuminate the role that a large stationary lead emitter plays in the health of a surrounding community's children. This report will describe the details of the study methods and the results obtained from the data collection efforts.

3. STUDY METHODS

3.1 STUDY DESIGN AND POWER CALCULATIONS

The study design was cross-sectional. The 'exposed' community of Hacienda Heights is located adjacent to Site 1, a large battery recycling facility in the City of Industry. West Covina is a town without a large stationary lead source and was selected as a 'control' community. The housing stock, demographic characteristics and vehicular traffic patterns in West Covina are similar to those of Hacienda Heights. A group of 122 children, ages 1 to 5, were identified in both the 'exposed' and 'control' community, comprising a total sample size of 244 children.

Power calculations were conducted to assess the ability of this study to detect differences in mean blood lead levels of 2 ug/dl between the two study sites. Assuming a sample size of 122 children at each site for a total sample size of 244, there was 99% power to detect differences in the two means at an alpha level of 0.05.

3.2 IDENTIFICATION OF STATIONARY LEAD SOURCE

The selection of the study site was based upon several criteria: 1) ambient lead concentrations ascertained through the South Coast Air Quality Management District's (SCAQMD) special monitoring program for particulate lead near major secondary lead sources in Southern California; 2) results from soil sampling conducted near lead facilities by the Los Angeles County Department of Health Services (LACDHS) and the California Environmental Protection Agency (Cal-EPA); 3) the quantity of lead processed at a facility; 4) the existence of known violations of the California ambient lead standard (1.5 ug/m^3 as a monthly average); 5) the proximity of a residential community to the stationary lead source and 6) the likelihood that ambient lead would migrate to a residential area due to prevailing wind patterns, distance and the presence or absence of physical structures. Three facilities met these criteria in Los Angeles County: Site 1, a battery recycler in the City of Industry; Site 2, a brass manufacturer in Pacoima; and Site 3, a manufacturer of lead oxide, in Bell Gardens.

Site 1 was selected as the site for the project. Site 1 had an exceedance of the state of California ambient lead standard in July of 1991 when the average monthly ambient lead value was 1.84 ug/m^3 (SCAQMD, 1991). There were no other exceedances near residential areas reported at the three other facilities during the period of SCAQMD's special ambient lead monitoring project. Soil sampling for lead was also conducted near Site 1 in December of 1991 by Cal-EPA (Cal-EPA, 1992). A total of 50 samples were collected up to 3,200 feet from the company's fenceline in the industrial and residential areas surrounding the facility. The range in values of these samples was 35 to 10,300 parts per million(ppm). The geometric mean of these samples was 334 ppm and the arithmetic mean was 810 ppm. Nine of the fifty soil samples were obtained in the nearby residential area and ranged in lead concentration from 47 to 770 ppm with an arithmetic soil lead concentration of 304 ppm. Two additional soil samples were obtained by LACDHS in the residential area south of Site 1 and were found to have a lead content of 380 and 580 ppm.

The data from the other two facilities that were considered revealed no exceedances of the state ambient air lead standard and somewhat lower soil lead values. Six soil samples were obtained in the residential areas in the path of the wind deposition near Site 2 and four similar soil samples were obtained near Site 3. At Site 2, the soil lead samples ranged from 59 to 220 ppm with an average of 141 ppm soil lead. At Site 3, the samples ranged from 76 to 500 ppm with an average soil lead of 259 ppm.

Data were available from the SCAQMD on the tons of lead processed per year at each facility. At Site 1, 148,920 tons of lead are processed per year; at Site 2, 390 tons of lead are processed each year; and at Site 3, 36,165 tons are processed each year. Site 1 is the largest processor of lead in the SCAQMD's jurisdiction which includes Los Angeles, Orange, Riverside and the non-desert portion of San Bernadino Counties.

3.3 IDENTIFICATION OF EXPOSED AREA

SCAMQD staff conduct regular ambient monitoring south of Site 1. As part of this effort, meterological data on wind patterns are available. According to these data, the winds in the area move in a west to east and southeast direction predominantly. This suggests that the most affected residential area is along Clark Street, the east-west residential street that runs along the south side of the plant (See Figure 1). The most affected area is projected to be the residences on Clark Street, with the pattern "fanning" out to the south towards Turnbull Canyon Road. The study area includes a portion of the community of Hacienda Heights. The study area is bordered on the north by Clark Street, the west by 6th Avenue, the east by Turnbull Canyon Road, and on the south by the Pomona Freeway.

3.4 SELECTION OF A CONTROL AREA

A community that was similar to Hacienda Heights with respect to demographics, housing stock and vehicular traffic patterns was selected as the control area. The purpose of the selection of a control community was to examine lead levels in a community without a major lead source to determine background or expected biologic and environmental lead levels in a community that was comparable to Hacienda Heights. The area selected was a portion of the city of West Covina, approximately 3 miles to the north of Hacienda Heights.

3.5 POPULATION SURVEY AND IDENTIFICATION OF ELIGIBLE SUBJECTS

Project staff went door-to-door in the two study areas to conduct censuses of all children who were eligible to participate in the project. If an adult member of the household was at home, the project was described and participation was requested if there were eligible children living in the household. If no adult was at the home, a letter describing the project was left with a request to call the project office at the residents' earliest convenience to inform the project office if there were eligible children living at the household. Follow-up telephone calls were made to the eligible households and appointments were made to return to the home to collect biologic and environmental samples and administer a detailed questionnaire. Households that did not respond to the letters were contacted at least four times either in-person or by telephone using a reverse telephone directory.

Children who were eligible to participate were required to have lived in their home for at least three months prior to data collection. This was due to the fact that a child's blood lead level at a given point in time reflects the previous 30-60 days of lead exposure. Lead exposures of interest in this study were only those that occurred while the child lived in Hacienda Heights or West Covina.

3.6 PUBLIC OUTREACH AND INFORMATION CAMPAIGN

There was a special effort in this project to involve the targeted communities. This included community meetings in Hacienda Heights and West Covina before the start of the study, during the study and after the completion of the project. The major objective of the meetings was to encourage community participation in the project. A description of the study was presented at the meetings and emphasis was placed upon the importance of the investigation to the public health of the community. Educational materials on the health effects of lead exposure were provided at the meetings and were discussed by the principal investigator during the presentation. The sampling methods that were used to collect data in the homes were also described in order to avoid concern by the study participants once sampling in the homes began.

All results of biologic and environmental sampling conducted in each home were sent to each household. In the letter describing the results, recommendations were made to the residents as to how they may reduce lead exposure to the young children living in their homes, and the families were provided with a schedule for future blood lead screening for their children. If requested by a parent, a letter was also sent to a child's pediatrician describing the results of the child's blood lead test.

3.7 QUESTIONNAIRE

An extensive two-part questionnaire was developed to ascertain information on a child's play behavior; major changes in the yard such as soil removal or paving; painting or paint removal; household members working in lead-exposed occupations; and the hobbies of household members involving lead exposure. The first part of the questionnaire was administered to the child's parent or guardian by the certified phlebotomist who had undergone training in the techniques of questionnaire admininstration. The second section of the questionnniare was an environmental survey of the home and included an assessment of the condition of the paint in the home; the degree of dustiness in the home; and other information related to the physical environment of the home. This questionnaire was administered by the project environmental health technician who was also trained in the techniques of questionnaire administration. All questionnaires were translated into Spanish and administered to the parent or guardian by a bilingual project staff member in the Spanish-speaking households.

3.8 COLLECTION OF BIOLOGIC AND ENVIRONMENTAL SAMPLES

An attempt was made to collect a venous blood sample from every child, one to five years of age, who had lived in the home for at least three months. Details on the techniques for the collection of venous blood samples can be found in Appendix A. A household dust sample and two paint chips were collected from the child's major indoor play area. Details on the collection of dust and indoor paint samples can be found in Appendices C and D. Any suspicious imported ceramic ware was also tested for lead (See Appendix G). Samples collected outside the home included four composited soil samples (See Appendix B); two outdoor paint chips (See Appendix E) and ambient measurements for lead (See Appendix F).

The four outdoor soil samples were collected from the backyard, frontyard, around the path leading to the home, and from the side of the house. The backyard, frontyard and path samples were collected to examine the lead in the soil from the outdoor air and are presented individually and as an average representing outdoor soil lead levels. The soil sample from the side of the house was obtained as a measure of lead in the soil from the outdoor housepaint. Each outdoor soil sample was a composite of four samples collected in each area.

A random sample of 51 soil samples in Hacienda Heights and 45 samples in West Covina were tested for four additional metals: arsenic, antimony, copper and cadmium. In Hacienda Heights, a random sample of 51 backyard or frontyard samples was analyzed for additional metals, depending upon which sample was closest to Site 1. In West Covina, a random sample of 45 backyard or frontyard samples was randomly selected for analysis of additional metals. The soil was analyzed for these metals in order to determine if the lead in the soil near Site 1 was from the smelter or from another source. That is, if there are other metals from the smelter in the residential soil near Site 1, it can be inferred with greater certainty that the lead in the soil is from Site 1 and not from outdoor housepaint or vehicle exhaust emissions. The levels of these metals were compared between the two communities.

The two outdoor paint samples were collected from the child's outdoor play area and the two indoor samples were obtained from the child's primary indoor play area. Indoor and outdoor paint samples were preferentially obtained from an area that was peeling or flaking. An air monitor was placed in a representative area in each of the two communities. Air lead measurements were collected every three days. Analysis of housedust sample results were completed for all residences in Hacienda Heights and approximately half of the residences in West Covina. These data are presented in the results section.

Families were asked to identify any imported pottery in which food was served to the children participating in the study. These pieces were tested for the presence of lead using a lead swab test that allowed for a positive or negative identification of lead. This test did not allow for a quantification of the lead content of the pottery.

3.9 QUALITY ASSURANCE PLAN

A split sample of 10% of all blood samples was collected and sent to a second certified laboratory for confirmatory analyses. In addition, a split sample of 10% of the soil and paint analyses was collected and sent to a certified laboratory for confirmatory analyses. No other laboratory conducts the analysis of the dust samples that was performed by the State Environmental Health Laboratory(EHL) in Berkeley, rendering split sample analysis of the dust samples impossible. Instead, in 10% of the homes, a dust sample field blank was collected to examine for contamination of the filters and sent to EHL for analysis.

3.10 VARIABLES

Demographic data on the age of the children, sex, ethnicity, and household income was collected. This data is compared to the demographic data on the general population in the census tracts of Hacienda Heights and West Covina to determine if the study groups are representative of the communities as a whole.

Blood lead levels were measured in micrograms per deciliter(ug/dl) of blood. The limit of detection of the method of analysis used for analyzing the lead in the blood is 5.0 ug/dl. All samples reported as less than 5 ug/dl lead, the analytical limit of detection, were mathematically considered 2.5 ug/dl, the midpoint between 0 and 5 ug/dl.

Analyses are conducted illustrating the mean blood lead level across categories of backyard soil lead levels for each study area. Backyard soil lead concentration will be less affected by lead from vehicles and may more clearly reflect lead in the soil from the nearby stationary lead source. Mean blood lead level is also shown by indoor and outdoor paint lead levels; the condition of the indoor and outdoor paint; the primary location of a child's weekday hours; the number of hours that a child plays outside; and the type of ground on which a child plays.

3.11 STATISTICAL METHODS

Descriptive statistics of all environmental and biologic variables are presented including the arithmetic mean, standard deviation and the 95% Confidence Intervals (95% CI's). Geometric means, geometric standard deviations and 95% CI's are also presented for variables that are not normally distributed in order to better illustrate the central tendency of these data.

Comparisons between the study and the control areas are conducted with T-Tests using SAS (SAS, 1993). If variables are not normally distributed, the data are log-transformed and the T-tests are conducted on the log-transformed data. For analysis of categorical data, chi-square tests are conducted. Results of multiple regression analysis are also presented. Pearson Correlation coefficients were calculated to examine the association between environmental and blood variables and are presented in the results section.

4.0 RESULTS

4.1 PARTICIPATION RATES

A total of 934 homes were identified from the census in Hacienda Heights. Of the 934 total households in the community, 98 or 10% were never contacted after at least four attempts by the study staff. Of the 836 homes with whom contact was made, 147 or 18% were eligible to participate or had a child ages 1 to 5 who had lived in Hacienda Heights for at least 3 months. Of the 147 eligible households in the community, data collection was completed in a total of 95 households (65%). There were 122 children, ages 1 to 5, living in these 95 households.

In the control community of West Covina, a total of 1,532 homes were identified in the census. Of the total households, 217 (14%) were never contacted after repeated attempts by the project staff. Of the 1,315 households contacted, 172 households (13%) were eligible to participate. Of the 172 eligible households, 92 or 53% agreed to participate. There were also 122 children living in these 92 households.

4.2 DEMOGRAPHICS OF STUDY AND CONTROL GROUP

Table 1 presents the demographic information on children in Hacienda Heights and West Covina. The age distribution was similar between the two groups with slightly more representation of two year olds in West Covina (24%) than in Hacienda Heights (16%). The distribution by sex is similar between the two communities. There is no data available on the general population of these census tracts by individual year under age five for purposes of comparison.

The ethnic distribution of the two study areas was similar with slightly more whites in Hacienda Heights (30%) than in West Covina (20%) (See Table 1). Both study groups were approximately 60% Latino. The study groups have a greater percentage of Latinos than the general population of Hacienda Heights and West Covina, using Bureau of the Census census tract data (U.S. Department of Commerce, Bureau of the Census, 1990a). In the general population of Hacienda Heights, approximately 44% of the population was Latino. In West Covina, the general population was approximately 46% Latino.

The distribution of household income of the exposed and control groups is shown in Table 1 and is similar for the two groups. When compared to the general population of Hacienda Heights, the study group is slightly overrepresented in the lower income groups and underrepresented in the upper income groups (U.S. Department of Commerce, Bureau of the Census, 1990b). In West Covina, the households that participated in the project are also overrepresented in the lower income group (less than $15,000) and underrepresented in the higher income groups (greater than $45,000) when compared to the general population of the area.

The age of the housing units, as reported by the parents in the two communities, is also shown in Table 1.

4.3 BLOOD LEAD RESULTS

The distribution of blood lead levels for Hacienda Heights and West Covina is shown in Table 2. In Hacienda Heights, 62% of the children have blood lead levels below the limit of detection (<5 ug/dl) and 75% of the children in West Covina have blood lead levels below 5 ug/dl. Slightly more children in Hacienda Heights (37%) have blood lead levels between 5 and 9 ug/dl than in West Covina (23%). A chi-square test comparing children with blood leads less than 5 ug/dl to those with blood lead levels of 5-9 ug/dl in Hacienda Heights and West Covina was equal to 5.5 with a p-value of 0.02.

As shown in Table 3, the arithmetic mean blood lead level in Hacienda Heights is 3.8 ug/dl and the geometric mean is 3.5 ug/dl. The arithmetic mean blood lead level in West Covina is 3.5 ug/dl and the geometric mean is 3.1 ug/dl. Table 3 also shows a comparison of the means of the log-transformed blood lead levels in the two communities, using T-tests. There was no difference in the mean blood lead level of the children in the two communities.

The mean blood lead levels of the children in Hacienda Heights and West Covina, stratified by the age of the child, is presented in Table 4. There were no appreciable differences in mean blood lead levels by the age of the child. The mean blood lead levels according to the sex of the child are shown in Table

5. Male children in Hacienda Heights have slightly higher blood lead levels than female children in Hacienda Heights. There was no difference in the mean blood lead levels by sex in West Covina.

4.4 SOIL LEAD RESULTS

The distribution of soil lead concentrations in the front yard, back yard, side yard, path and a combined front, back and path sample for Hacienda Heights and West Covina is presented in Table 6. The majority of the soil samples had lead concentrations less than 200 parts per million (ppm).

The arithmetic and geometric means, standard deviations and 95% confidence intervals for the soil data are shown in Table 7. The results of t-tests comparing mean soil lead levels between Hacienda Heights and West Covina is also presented in Table 7. The soil lead data is not normally distributed and is log-transformed when compared across study groups. The mean soil lead content is higher in Hacienda Heights than West Covina for all soil samples with the exception of the path soil sample.

The mean blood lead level for children according to their backyard soil samples is presented in Table 8. The mean blood lead level is slightly higher for children in Hacienda Heights where backyard soil samples are 201-400 ppm.

4.5 ADDITIONAL METAL ANALYSES OF SOIL

A comparison of the mean of the four additional metals identified in the random samples of soil is shown in Table 9. The antimony and arsenic data were normally distributed in the two communities and were not log-transformed for purposes of comparison by T-Test. The copper and cadmium data were not normally distributed and did undergo log transformation. As shown in Table 9, the mean concentration of antimony and cadmium in the soil was higher in Hacienda Heights and the mean concentration of the arsenic in the soil was higher in West Covina. There were no differences in the mean copper level in the soil in Hacienda Heights and West Covina.

4.6 PAINT LEAD RESULTS

The frequency distribution and comparison of paint lead levels for Hacienda Heights and West Covina are presented in Table 10. The variables were log transformed for purposes of comparison between study areas, as the distribution of the indoor and outdoor paint lead levels were not normally distributed. As shown in the results of the T-tests in Table 10, there was no difference in the indoor paint lead levels in Hacienda Heights and West Covina, and the outdoor paint lead levels in Hacienda Heights were higher than those in West Covina.

The mean blood lead levels are presented in Table 11 by indoor and outdoor paint lead measurements in homes in Hacienda Heights and West Covina. No particular pattern or trend is evident from these analyses.

Blood lead levels were also examined for an association with the condition of the indoor and outdoor housepaint in the home. The results of these analyses are shown in Table 12. There were slightly higher blood lead levels in children in Hacienda Heights who lived in homes where there was a lot of indoor paint flaking and peeling.

4.7 DUST LEAD RESULTS

As of the time of the publication of this document, approximately 75% of the analyses of housedust lead samples had been completed. Analyses were therefore based upon dust samples from the total 95 households that were tested in Hacienda Heights and for 39(42%) of the 92 homes tested in West Covina.

The dust lead results are presented in Table 13. The geometric mean is the best measurement of the central tendency of these data, as these data are not normally distributed. Almost 70% of the house dust lead measurements in Hacienda Heights and 86% of the homes in West Covina had less than 200 ppm lead. A t-test on the log transformed dust data shows that the housedust lead levels were somewhat higher in Hacienda Heights than West Covina. This result is based upon incomplete data, however.

4.8 AIR LEAD DATA

The geometric mean of the air lead levels in Hacienda Heights and West Covina during the period of data collection were 0.05 microgram per meter cubed (ug/m^3) and 0.03 mg/m^3, respectively (See Table 14). The range in air lead levels in Hacienda Heights was 0-0.2 ug/m^3 and in West Covina the range in air lead levels was 0.02-0.04 mg/m^3. The air lead data was not normally distributed. A comparison of the two means of the log-transformed data in these two communities was conducted using a t-test and the t-statistic was 2.9 with a p-value of 0.007, sugggesting that the air lead levels in Hacienda Heights were higher than those obtained in West Covina during the study period.

4.9 POTTERY RESULTS

In Hacienda Heights, 12(13%) of the 95 homes identified imported pottery from which their young children ate food. Of the 27 pieces of pottery identified in the 12 homes, 11 or 41% tested positive for lead using a lead swab test kit. In the control community of West Covina, 20(22%) households of the 92 included in the project were able to identify imported pottery suspected to contain lead. In these 20 homes, 48 pieces of pottery were tested. Of the 48 tested, 15 or 31% tested positive for lead using the lead swab test kits.

4.10 PLAY ACTIVITIES

A child's blood lead level was examined for an association with a child's play behavior. In Table 15, the mean blood lead level for a child is shown according to where a child spends most of his or her weekday daytime hours. There is no effect on blood lead level according to whether or not a child is primarily at home or somewhere else during the week. In Table 16, the mean blood lead level for a child is shown according to the number of hours a child spends playing outside at his or her home in an average week. A very slight trend emerges with an increase in blood lead levels by an increase in the number of hours spent playing outside. The mean blood level of a child according to the type of ground that he or she usually plays on in his or her yard is shown in

Table 17. Children who play on uncovered ground have higher blood lead levels than children who play on covered ground in both Hacienda Heights and West Covina.

4.11 SOIL LEAD ISOPLETHS

The backyard soil lead isopleths are shown in Figures 2 and 3. Figure 2 shows the backyard soil lead isopleths for 200 ppm lead and Figure 3 shows the isopleths for 100 ppm lead. In Figure 2, the inside of the lined areas represents the connection of backyard soil data points that were above 200 ppm. The pattern that emerges in Figure 2 is a corridor along Seventh Avenue of soil lead levels in excess of 200 ppm. The same pattern can be seen in Figure 3 in which there is a clustering along the east side of Seventh Avenue of backyard soil lead levels above 100 ppm. The 100 and 200 ppm contours are based upon a small number of data points and should be interpreted with caution.

4.12 MULTIPLE REGRESSION ANALYSES

The usefulness of multiple regression analysis is limited in these data, as there is no disease to predict. That is the blood lead levels of the children in Hacienda Heights are normal. Thus, the parameter estimates in the multiple regression analysis represent predictors of varying degrees of normality. Variables were chosen for the models based upon prior knowledge and the results of the bivariate analyses. Age and sex were included in the model as age and sex are potential confounders of the exposure-disease association. The results are presented in Tables 18.

As shown in Model 1 in Table 18, the variables that are most predictive of the log-transformed blood lead levels are the age of the child, the log-transformed backyard soil lead levels and the absence of ground cover in the area where the child normally plays. Variables that were unrelated to a child's blood lead level were the sex of a child; whether a member of the household worked in a lead-using occupation; whether there was lead-containing pottery in a home; outdoor paint lead levels; indoor paint lead levels; and average outdoor air lead levels for the thirty days prior to the drawing of a child's blood; and whether a child brought toys or a bottle outside while playing..

Data on the housedust lead levels was completed for all households in Hacienda Heights and less than half of the households in West Covina. A separate model was therefore fitted that included housedust lead data, as this model only includes 75% of the study population. As shown in Model 2 in Table 18, age, sex, backyard soil lead and housedust lead levels are of borderline significance. The absence of ground cover in a yard is again predictive of blood lead levels.

4.13 CORRELATION ANALYSIS

Correlation coefficents assessing the correlation between environmental variables (soil, paint, air and dust lead) and blood lead levels for each child are presented in Table 19. Associations can be seen between blood lead levels versus backyard soil lead and housedust lead; backyard soil lead versus frontyard soil lead, side of the house soil lead and housedust lead; frontyard soil lead versus path soil lead, the side of the house soil lead, the summary soil lead measurement, outdoor paint lead, and indoor paint lead; path soil lead levels versus the side of the house soil lead, the summary soil lead, and the indoor paint lead; side of the house soil lead versus summary soil lead, outdoor paint lead, indoor paint lead, outdoor air lead and housedust lead; summary soil lead is associated with all the soil lead measurements and both indoor and outdoor paint measurements; outdoor paint lead is associated with indoor paint lead and housedust lead; indoor paint is associated with the summary soil lead and outdoor paint lead; and outdoor air is associated with the side of the house soil lead.

4.14 QUALITY CONTROL DATA

The results from the split samples of blood, soil and paint that were sent to a second laboratory were essentially identical to the split of those same samples that were sent to the primary laboratory.

5.0 DISCUSSION

5.1 Participation

The participation rates in this project were somewhat low with 65% of eligible households agreeing to participate in Hacienda Heights and 53% of eligible households agreeing to participate in West Covina. It should be noted that this low level of participation is typical for this type of study (Cook et al, 1993). Because of the low participation rate, it was important to determine if the households who did not participate in the project were different in some important characteristic from those who did participate. It was not possible to collect data on those not participating in the project, however those who did participate were compared to the general population of the two study areas to examine if the study group was representative of the general population of the two communities. This was accomplished using Bureau of the Census data on population characteristics by census tract (U.S. Department of Commerce, 1990a; U.S. Department of Commerce, 1990b).

5.2 Demographics

For the most part, the study groups were similar to the general population of the two communities. The increase in representation in Latinos in Hacienda Heights and West Covina compared to the general population in these two communities may be explained by the fact that Latinos tend to have more children, making Latinos more likely to be eligible to participate in the project.

There was slight overrepresentation in Hacienda Heights and West Covina by families in lower income groups, and underrepresentation by families in upper income groups. The participation of more lower versus upper income households may be explained by the offer of free environmental and biological testing. This incentive may have been more attractive to lower income families.

The data on the age of the housing in the two communities is not completely reliable, as approximately one-third of both study group participants did not know when their house was built.

5.3 Blood Lead

The blood lead levels in the community near the secondary lead smelter were within the range of normal. The U.S. Centers for Disease Control(CDC) considers blood lead levels in young children that are less than 10 ug/dl to be within the range of normal (CDC, 1991). Blood lead levels in both communities were within this range. In fact, 62% of the children in Hacienda Heights and 75% of the children in West Covina had blood lead levels less than 5 ug/dl, the analytical detection limit. Based upon the Mantel-Haenszel chi-square test, more children in Hacienda Heights than West Covina had blood lead levels between 5 and 9 ug/dl. However, it should be noted that the standard deviation on the analytical method for analyzing lead in the blood is 4 ug/dl. The variation in the analytical method alone could explain the differences in the distribution of children with blood lead levels less than 5 ug/dl versus those with blood lead levels between 5 and 9 ug/dl.

As shown in Table 3, there was no appreciable difference between the log-transformed mean blood lead level in the two communities.

Further analyses that stratified blood lead levels by other factors such as age, sex, soil lead levels and paint lead levels should be viewed with some caution. That is, all of the blood lead levels in the study subjects were low. Any differences observed are limited in importance, as the levels represent varying degrees of normality.

There were no important differences in mean blood lead level by age (See Table 4) or sex (See Table 5). In Hacienda Heights, boys had a slightly higher mean blood lead level than young girls. However the mean blood lead level of the boys can not be considered excessive (mean=4.3 ug/dl), as this level is below the limit of detection. It should be noted that higher blood lead levels are typically seen in boys compared to girls and is typically explained by the more active play that boys engage in when compared to girls.

A slight elevation (mean=5.4 ug/dl) was seen in children in Hacienda Heights with a backyard soil lead level between 201 and 400 ppm (See Table 8), however there were small numbers in this strata (n=7). In addition, a blood lead level of 5.4 ug/dl is not known to be associated with adverse health effects. It should be noted that 5.0 ug/dl is the analytical limit of detection, or the lowest value observable with the analytical technique. There also was no apparent pattern in blood lead level by indoor and outdoor paint lead level (See Table 11).

There was a slight elevation in blood lead levels (mean=5.0 ug/dl) in children in Hacienda Heights living in homes with a lot of flaking or peeling indoor paint (See Table 12). A slight dose-response effect may be seen in the Hacienda Heights data. Again, a blood lead level of 5.0 ug/dl is not considered to be associated with adverse health effects. There was no difference in mean blood lead level according to where a child spends most of his or her weekday hours (See Table 15). There was a slightly increasing trend in blood lead levels in Hacienda Heights by the number of hours spent playing outside if the mean blood lead level in the highest category with only one observation is ignored (See Table 16).

Children living in Hacienda Heights and West Covina who usually play in an area without ground cover had higher blood lead levels than children who usually play in an area with ground cover (See Table 17). Again, the higher blood lead level is not a blood lead level of great concern. This is an interesting finding, as the result suggests that ground cover may act as a barrier to a child experiencing lead exposure from dirt in a yard and is consistent with other findings (CDC, 1991; California Department of Health Services, 1991). When there is no ground cover in a yard, there is likely to be more generation of lead-containing dust which can cling to a child's hands, toy or bottle. Once that child puts the hand, toy or bottle in his or her mouth, he or she may experience more lead exposure. It is also important to note that this difference in the effect of ground cover on blood lead levels was also present in West Covina, a community without a lead smelter. It is likely that other lead sources such as outdoor housepaint are contributing to the lead in the soil in West Covina.

5.4 Soil Lead

The majority of the soil samples in both communities had soil lead levels that were less than 200 ppm (See Table 6). The State of California Department of Health Services and the U.S. Environmental Protection Agency consider soil with 1000 ppm or more lead as hazardous waste (California Department of Health Services, 1991). The State of California Department of Health Services recommends that if young children are living in a home, precautions should be taken if soil lead levels are over 200 ppm and there is minimal ground cover in a yard.

The soil lead levels were slightly higher in Hacienda Heights than West Covina (See Table 7). However the geometric mean of the summary soil measure in Hacienda Heights is 107 ppm and is a level commonly found in urban soil (California Department of Health Services, 1991). The important point is that although the soil lead levels are slightly elevated, the lead in the soil is not associated with measurable increases in blood lead levels in children in Hacienda Heights.

5.5 Additional Metal Analyses

Other metals have been emitted from Site 1 as a byproduct of the recycling of batteries. These metals include antimony, arsenic, cadmium and copper. It was believed that if these metals were also found in the soil near Site 1, the lead in the soil could more definitively be linked to the emissions from the secondary smelter rather than other lead sources. The levels of antimony and cadmium were both higher in Hacienda Heights than West Covina, and the soil concentration of arsenic was higher in West Covina. The finding of elevated antimony levels supports the assertion that the lead in the soil in Hacienda Heights is from Site 1, as antimony in particular is associated with the recycling of batteries (Doe, 1978).

5.6 Soil Lead Isopleths

It is impossible to definitively determine the source of the slightly elevated backyard soil lead emissions along the north-south corridor of Seventh Avenue, as seen in the soil lead isopleths in Figures 2 and 3. However it is likely that these elevations are due to vehicular lead emissions. Seventh Avenueis a heavily traveled street and the winds in this area move in a predominantly west to east direction. The fact that the winds move in a west to east direction may explain the elevations seen on the west side of the street and not on the east side of the street. It is possible, however, that the elevations in backyard soil lead are due to emissions from Site 1, particularly given that levels of other metals associated with battery recycling were also detected in the soil.

5.7 Paint Lead

There are two points of reference for paint lead measurements: the U.S. Consumer Product Safety Commission (CPSC) standard for lead paint is 600 ppm; and the U.S. Department of Housing and Urban Development (HUD) standard is 5000 ppm. Generally, levels of lead in paint above 5000 ppm are believed hazardous for children if the paint is deteriorated (CDC, 1991).

The indoor paint levels were not at a level of concern in Hacienda Heights (geometric mean = 436 ppm) or West Covina (geometric mean = 480 ppm). There was no difference in indoor paint lead measurements in Hacienda Heights and West Covina, however outdoor paint lead measurements were higher in Hacienda Heights. This elevation in outdoor paint lead levels may explain the higher soil lead measurements in Hacienda Heights in the soil sample taken from the side of the house. That is, the lead in the soil sample obtained from the side of the house is likely to be from outdoor paint. Although the outdoor housepaint lead measurements are slightly elevated in Hacienda Heights compared to those in West Covina, the lead in the paint is not biologically available to the young children, as evidenced by the low blood lead levels of the children in Hacienda Heights.

5.8 Dust Lead

Housedust lead samples were analyzed for all of Hacienda Heights and half of West Covina. There is no standard for dust lead levels. However the CPSC standard of 600 ppm for lead in housepaint and the EPA level of 1000 ppm lead in soil, and the California Department of Health Services recommended level of 200 ppm in soil can be used as approximate points of reference.

There are other reports in the literature of housedust lead sampling. Although the methods used for the collection of these samples are different from those used in this study, the results are approximately comparable. Dust lead concentrations in households in Hacienda Heights were consistently lower than housedust lead concentrations in homes in Leadville, Colorado, a residential area located in close proximity to a mining community (Cook et al, 1993). Concentrations of lead in housedust in this community were approximately 2000 ppm. Another study reported indoor housedust concentrations of 11,000 ppm (Lepow et al, 1975) in children living in an urban environment in Hartford, Connecticut. The housedust lead concentrations found in this study in Hacienda Heights were low compared to housedust lead concentrations reported in these other studies (Geometric Mean=157 ppm). There was no association found in Hacienda Heights data between housedust lead and the blood lead levels of the children tested.

5.9 Air Lead

The ambient air lead standard in the state of California is 1.5 ug/m^3 as a thirty-day average. The highest air lead concentration measured in Hacienda Heights during the study was 0.2 mg/m^3 and the geometric mean was 0.05 ug/m^3. The highest reading (0.2 ug/m^3) is seven and a half times lower than the current standard. The air lead concentrations in Hacienda Heights are low. However it is interesting to note that these concentrations are higher than the measurements found in West Covina, a community without a lead smelter.

5.10 Multiple Regression Analysis

As mentioned in the Methods section, the results of the multiple regression analysis must be viewed with some caution. There was no adverse health outcome to predict, as the blood lead levels of the children were all within acceptable limits. Given that the variables in the model are predicting degrees of normality, the variables that were most predictive were a child's age and whether there was ground cover where a child normally played. The modeling results show that blood lead levels were higher for younger children which is not unexpected, as younger children have more hand to mouth behavior than older children. These findings are consistent with other results found in the literature (CDC, 1991; California Department of Health Services, 1991). Variables that were of borderline significance with respect to an association with blood lead levels were backyard soil lead levels and housedust lead. Variables that were not associated with blood lead levels included paint lead and air lead.

5.11 Correlation Analysis

The associations between the various soil measurements is to be expected. The association between outdoor paint and side of the house soil lead is most likely explained by the lead in the soil from the outdoor paint. The association between indoor housedust lead and outdoor soil lead and outdoor paint lead adds uncertainty to the source for the lead in the indoor housedust.

5.12 Conclusions

Soil lead, air lead and dust lead levels in Hacienda Heights were higher than those in West Covina. Although the soil lead concentrations were higher in Hacienda Heights than West Covina, the concentrations are not unlike soil lead levels frequently found in urban soil (Centers for Disease Control, 1991). It is likely that some of the lead in the soil in the residential yards in Hacienda Heights is from the battery recycling facility, Site 1, as soil antimony associated with battery recycling was also elevated. However, environmental lead exposures in the vicinity of this large lead acid battery recycling facility was not associated with abnormal blood lead levels in neighborhood children. Any incremental public health risk in this neighborhood due to community lead exposures appears to be very low.

Table 1

Demographic Data for Hacienda Heights and West Covina

VARIABLE*	Hacienda Heights N	Hacienda Heights %	West Covina N	West Covina %
Age Category				
1 Year	15	12	19	15
2 Years	19	16	29	24
3 Years	25	20	22	18
4 Years	33	27	29	24
5 Years	30	25	23	19
Sex				
Male	57	47	64	53
Female	65	53	58	47
Ethnic Category				
Latino	75	62	73	60
White	37	30	24	20
Black	0	0	14	12
Asian	8	7	11	9
Other	2	2	0	0
Primary Language Spoken In Household				
English	93	76	77	63
Spanish	25	21	35	29
Other	4	3	10	8
Household Income				
Less than 15,000	26	21	29	24
15-29,000	28	23	17	14
30-44,000	24	20	34	28
45-59,000	21	17	19	16
60-74,000	14	12	12	10
Greater than 75,000	5	4	9	7
Not available	4	3	2	2
Age Of Housing Unit				
Pre-1950	51	42	55	45
1950 & Later	32	26	22	18
Not available	39	32	45	37

* Sample size is number of children

Table 2

Distribution of Blood Lead Levels(ug/dl) in Children in Hacienda Heights and West Covina

	Hacienda Heights		West Covina	
Blood Lead Level	**N**	**%**	**N**	**%**
<5 ug/dl	76	62	92	75
5-9 ug/dl	45	37	28	23
10-14 ug/dl	1	1	2	2

Chi-square comparing children with blood lead levels <5 ug/dl to 5-9 ug/dl in Hacienda Heights and West Covina = 5.5; p-value=0.02.

Table 3

Arithmetic and Geometric Means, Standard Deviations, 95% Confidence Limits and T-Test Results of Blood Lead Levels(ug/dl) in Hacienda Heights and West Covina

	Hacienda Heights	**West Covina**
Arithmetic Mean	3.8	3.5
Standard Deviation	1.9	1.9
95% Confidence Limits	(3.5, 4.1)	(3.2, 3.8)
N	122	122
Geometric Mean	3.5	3.1
Standard Deviation	3.2	3.0
95% Confidence Limits	(2.9, 4.1)	(2.6, 3.6)
N	122	122

T-test on log-transformed blood lead levels in Hacienda Heights versus West Covina: T-statistic = 1.8; p-value = 0.07

Table 4

Mean Blood Lead Level & 95% CI's Stratified by the Age of the Child for Hacienda Heights and West Covina

	Mean Blood Lead Level (ug/dl)					
	Hacienda Heights			West Covina		
Age of Child	Mean	95% CI's	N	Mean	95% CI's	N
1	4.4	(3.3, 5.5)	15	3.9	(2.8, 5.0)	19
2	4.2	(3.2, 5.2)	19	3.9	(3.1, 4.7)	29
3	3.5	(2.8, 4.2)	25	3.9	(2.9, 4.9)	22
4	4.0	(3.3, 4.5)	33	3.0	(2.6, 3.4)	29
5	3.5	(2.9, 4.1)	30	2.8	(2.4, 3.2)	23

Table 5

Mean Blood Lead Levels & 95% CI's for Hacienda Heights and West Covina Stratified by Sex of Child

City	Sex of Child	N	Mean	SD	95% CI's
Hacienda Heights	Male	57	4.3	2.2	(3.7, 4.9)
	Female	65	3.5	1.6	(3.1, 3.9)

T-statistic on Mean Blood Lead Levels
of Males versus Females in Hacienda Heights = -2.1; p-value=0.04

West Covina	Male	58	3.8	2.2	(3.2, 4.4)
	Female	64	3.2	3.2	(2.8, 3.6)

T-statistic on Mean Blood Lead Levels
of Males versus Females in West Covina = -1.6; p-value=0.1;

Table 6

Distribution of Soil Lead Levels
for Households in Hacienda Heights and West Covina

	Hacienda Heights		West Covina	
	N	%	N	%
Frontyard Soil				
0-200 ppm	79	83	88	97
201-400 ppm	13	14	2	2
401-600 ppm	2	2	0	0
601-800 ppm	0	0	0	0
801-1000 ppm	0	0	1	1
1001-1200 ppm	1	1	0	0
Sample not collected			1	
Backyard Soil				
0-200 ppm	86	93	91	99
201-400 ppm	6	7	1	1
401-600 ppm	0	0	0	0
601-800 ppm	0	0	0	0
801-1000 ppm	0	0	0	0
1001-1200 ppm	1	1	0	0
Sample not collected	0	0	0	0
Path Soil				
0-200 ppm	77	82	85	92
201-400 ppm	14	15	6	7
401-600 ppm	3	3	0	0
601-800 ppm	0	0	1	1
801-1000 ppm	0	0	0	0
1001-1200 ppm	0	0	0	0
Sample not collected	1		0	0
Side Of House Soil				
0-200 ppm	69	74	88	97
201-400 ppm	19	20	3	3
401-600 ppm	2	2	0	0
601-800 ppm	2	2	0	0
801-1000 ppm	1	1	0	0
1001-1200 ppm	0	0	0	0
Sample not collected	2		1	
Average of Backyard, Frontyard and Path to Front of House				
0-100 ppm	43	47	70	77
101-200 ppm	38	41	18	20
201-300 ppm	8	9	2	2
301-400 ppm	2	2	1	1
401-500 ppm	1	1	0	0

Table 7
Arithmetic and Geometric Means of Soil Lead Levels(ppm) and T-Test Results

	Hacienda Heights	West Covina
Frontyard Soil		
Arithmetic Mean	124	135
Standard Deviation	125	468
95% Confidence Limits	(99, 149)	(39, 231)
N	95	92
Geometric Mean	92	71
Standard Deviation	1	5
95% Confidence Limits	(92, 92)	(70, 72)
N	95	92
T-Statistic on log-transformed variable:2.3; p-value=0.02		
Backyard Soil		
Arithmetic Mean	100	65
Standard Deviation	129	38
95% Confidence Limits	(74, 126)	(57, 73)
N	93	92
Geometric Mean	75	58
Standard Deviation	2	3
95% Confidence Limits	(75, 75)	(57, 59)
N	93	92
T-Statistic on log-transformed variable: 2.9; p-value=0.005		
Path Soil		
Arithmetic Mean	148	112
Standard Deviation	99	81
95% Confidence Limits	(128, 168)	(95, 129)
N	94	92
Geometric Mean	113	94
Standard Deviation	3	2
95% Confidence Limits	(113, 113)	(94, 94)
N	94	92
T-Statistic on log-transformed variable:1.5; p-value=0.1		
Side of House Soil		
Arithmetic Mean	172	91
Standard Deviation	180	59
95% Confidence Limits	(136, 208)	(79, 103)
N	94	91
Geometric Mean	125	76
Standard Deviation	1	3
95% Confidence Limits	(125, 125)	(76, 77)
N	94	91
T-statistic on log-transformed variable:4.7; p-value=0.0001		
Average of Backyard, Frontyard, and Path Soil Samples		
Arithmetic Mean	125	104
Standard Deviation	77	159
95% Confidence Limits	(109, 141)	(72, 137)
N	92	92
Geometric Mean	107	82
Standard Deviation	3	3
95% Confidence Limits	(106, 108)	(82, 83)
N	92	92
T-statistic on log-transformed variable:3.2; p-value=.002		

Table 8

Mean Blood Lead Levels in Children By Backyard Soil Lead Levels(ppm) in Hacienda Heights and West Covina

	Mean Blood Lead Level (ug/dl)							
	Hacienda Heights				West Covina			
Backyard Soil Lead Level (ppm)	Mean	SD	95% CI's	N	Mean	SD	95% CI's	N
0-200	3.8	1.9	(3.4, 4.2)	112	3.5	1.9	(3.2, 3.8)	120
201-400	5.4	2.1	(3.9, 6.9)	7	2.5	0.0	(2.5, 2.5)	2
401-600	-	-	- -	0	-	-	-	0
601-800	-	-	- -	0	-	-	-	0
801-1000	-	-	- -	0	-	-	-	0
1001-1200	2.5	-	- -	1	-	-	-	0
Missing Data	-	-	- -	2	-	-	-	0

Table 9

Distribution of Antimony, Arsenic, Cadmium and Copper (ppm) in Random Sample of Soil Samples in Hacienda Heights(HH) and West Covina(WC)

Metal	City	Mean	SD	95% CI's	N
Antimony	HH	5.2	0.6	(5.0, 5.4)	51
Antimony	WC	4.9	1.0	(4.6, 5.2)	45
T-Statistic=2.3; p-value=0.02					
Arsenic	HH	19.6	5.3	(18.1, 21.1)	51
Arsenic	WC	23.9	8.3	(21.5, 26.3)	45
T-Statistic=-3.03; p-value=0.003					
Cadmium	HH	0.9	1.2	(0.6, 1.2)	51
Cadmium	WC	0.6	0.4	(0.5, 0.7)	45
T-Statistic on log-transformed data=2.2; p-value=0.03					
Copper	HH	72.4	265.8	(0, 145.4)	51
Copper	WC	40.6	24.1	(33.6, 47.6)	45
T-Statistic on log-transformed data=-0.3; p-value=0.8					

Table 10

Indoor and Outdoor Paint Lead Levels for Hacienda Heights and West Covina

	Hacienda Heights N	Hacienda Heights %	West Covina N	West Covina %
Indoor Paint				
0-500 ppm	50	55	49	61
501-1000 ppm	20	22	16	20
1001-1500 ppm	10	11	6	7
1501-2000 ppm	5	6	2	3
2001-2500 ppm	0	0	3	4
2501-3000 ppm	1	1	1	1
3001-3500 ppm	2	2	1	1
3501-4000 ppm	2	2	2	3
>4000 ppm	1	1	2	3

	Hacienda Heights	West Covina
Arithmetic Mean	735	930
Standard Deviation	880	2442
95% Confidence Limits	(554, 916)	(401, 1459)
N	91	82
Geometric Mean	436	480
Standard Deviation	2	4
95% Confidence Limits	(436, 436)	(479, 481)
N	91	82

T-statistic on log-transformed indoor paint lead levels in Hacienda Heights versus West Covina = -0.3; p-value=0.8

	Hacienda Heights N	Hacienda Heights %	West Covina N	West Covina %
Outdoor Paint				
0-5000 ppm	64	67	70	81
5001-10000 ppm	16	17	9	11
10001-15000 ppm	5	5	3	4
15001-20000 ppm	4	4	2	2
20001-25000 ppm	2	2	1	1
25001-30000 ppm	0	0	0	0
>30000 ppm	4	4	1	1

	Hacienda Heights	West Covina
Arithmetic Mean	6511	3532
Standard Deviation	11663	5689
95% Confidence Limits	(4166, 8856)	(2330, 4734)
N	95	86
Geometric Mean	1773	1313
Standard Deviation	3	3
95% Confidence Limits	(1772, 1774)	(1312, 1314)
N	95	86

T-statistic on log-transformed outdoor paint lead levels in Hacienda Heights versus West Covina = 2.3; p-value=0.02

Table 11

Mean Blood Lead Levels in Children by Indoor and Outdoor Paint Lead Levels in Hacienda Heights and West Covina

	Mean Blood Lead Level (ug/dl)							
	Hacienda Heights				West Covina			
	Mean	SD	95% CI's	N	Mean	SD	95% CI's	N
Indoor Paint Lead Level(ppm)								
0-500	4.1	2.1	(3.6, 4.6)	64	3.3	1.8	(2.9, 3.7)	69
501-1000	3.5	1.8	(2.8, 4.2)	26	3.5	2.0	(2.6, 4.4)	21
1001-1500	4.3	2.2	(2.9, 5.7)	10	3.4	1.5	(2.3, 4.5)	7
1501-2000	2.9	1.0	(2.1, 3.7)	6	2.5	0	(2.5, 2.5)	2
2001-2500	-	-	-	0	4.9	3.5	(1.8, 8.0)	5
2501-3000	4.3	2.5	(0.8, 7.8)	2	2.5	-	(2.5, 2.5)	1
3001-3500	3.3	1.4	(1.7, 4.9)	3	2.5	0	(2.5, 2.5)	2
3501-4000	2.5	0	(2.5, 2.5)	4	-	0	-	0
>4000	4.8	3.2	(0.4, 9.2)	2	3.7	2.0	(1.4, 6.0)	3
Outdoor Paint Lead Level (ppm)								
0-5000	3.9	2.0	(3.5, 4.3)	80	3.3	1.9	(2.9, 3.7)	94
5001-10,000	4.0	2.2	(3.0, 5.0)	20	3.9	1.7	(2.9, 4.9)	11
10,001-15,000	3.3	1.3	(2.3, 4.3)	6	4.1	3.3	(0.9, 7.3)	4
15,001-20,000	4.9	1.3	(3.9, 5.9)	6	5.5	2.8	(2.3, 8.7)	3
20,001-25,000	2.5	0	(2.5, 2.5)	4	5.0	-	(5.0, 5.0)	1
25,001-30,000	-	-	-	0	-	-	-	0
>30,000	1.6	1.6		6	2.5	-		1

Table 12

Mean Blood Lead Levels in Children By Condition of Indoor and Outdoor Paint in Hacienda Heights and West Covina

	Mean Blood Lead Level (ug/dl)							
	Hacienda Heights				West Covina			
	Mean	SD	95% CI's	N	Mean	SD	95% CI's	N
Condition of Indoor Paint								
No Paint Peeling, Chipping or Flaking	3.7	1.8	(3.2, 4.2)	47	3.8	1.9	(2.8,4.8)	15
Some Paint Peeling, Chipping or Flaking	3.9	1.9	(3.5, 4.3)	71	3.4	1.9	(3.0, 3.8)	107
A lot of Paint Flaking or Peeling Off	5.0	3.5	(1.6, 8.4)	4	-	-	-	0
Condition of Outdoor Paint								
No Paint Peeling, Chipping or Flaking	3.7	1.8	(3.1, 4.3)	33	2.9	1.3	(2.3, 3.5)	20
Some Paint Peeling, Chipping or Flaking	3.9	2.0	(3.5, 4.3)	85	3.5	2.0	(3.1, 3.9)	87
A lot of Paint Flaking or Peeling Off	3.8	1.4	(2.4, 5.2)	4	3.8	1.9	(2.8, 4.8)	15

Table 13

Frequency Distribution, Mean and Standard Deviation of Dust Lead Measurements (ppm) for Households in Hacienda Heights and a Subset of Households in West Covina

	Hacienda Heights		West Covina	
Dust Lead Level (ppm)	**N**	**%**	**N**	**%**
0-100	17	18	20	22
101-200	48	51	29	32
201-300	24	25	5	5
301-400	1	1	1	1
401-500	3	3	1	1
501-600	1	1	1	1
601-700	1	1	0	0
Missing Data	0	0	35	38

	Hacienda Heights	West Covina
Arithmetic Mean	183	177
Standard Deviation	101	241
95% Confidence Limits	(163, 203)	(116, 239)
N	95	59
Geometric Mean	157	144
Standard Deviation	3	3
95% Confidence Limits	(157, 158)	(143, 145)
N	95	59

T-test on log-transformed dust lead measurement in Hacienda Heights versus West Covina: T-statistic= 2.06; p-value=0.04

Table 14

Arithmetic and Geometric Means, Standard Deviations, 95% Confidence Limits and T-Test Results of Air Lead Measurements(mg/m^3) in Hacienda Heights and West Covina

	Hacienda Heights	**West Covina**
Arithmetic Mean	0.06	0.03
Standard Deviation	0.05	0.006
95% Confidence Limits	(0, 0.1)	(0, 0)
N	34	25
Geometric Mean	0.05	0.03
Standard Deviation	2.7	2.7
95% Confidence Limits	(0, 1.0)	(0, 1.1)
N	34	25

T-Tests on log-transformed air lead measurements in Hacienda Heights versus West Covina: T-statistic = 2.9; p-value = 0.007

Table 15

Mean Blood Lead Levels (ug/dl) By Primary Location of Child's Weekday Hours

City	Location	Mean	SD	95% CI's	N
Hacienda Heights	Home	3.9	1.7	(3.4, 4.4)	38
	Elsewhere	3.8	2.1	(3.4, 4.2)	84
T-statistic = 0.4; p-value=0.7					
West Covina	Home	3.3	1.4	(2.8, 3.8)	25
	Elsewhere	3.5	2.0	(3.1, 3.9)	96
Missing Data		1			
T-statistic = -0.6; p-value=0.5					

Table 16

Mean Blood Lead (ug/dl) Levels Stratified By Hours Spent Playing Outside

City	Number of Hours Outside	Mean	SD	95% CI's	N
Hacienda Heights	0-4	3.4	1.6	(3.0, 3.8)	55
	5-9	4.2	2.3	(3.6, 4.8)	52
	10-14	4.2	1.8	(3.1, 5.3)	10
	15-19	4.9	1.7	(3.2, 6.6)	4
	>=19	2.5	-	-	1
West Covina	0-4	3.7	2.1	(3.0, 4.4)	37
	5-9	3.3	1.7	(2.9, 3.7)	62
	10-14	3.9	2.3	(2.9, 4.9)	19
	15-19	2.5	0.0	(2.5, 2.5)	4
	>=19	-	-	-	0

Table 17

Mean Blood Lead Levels Stratified By Type of Ground Child Usually Plays On Outside

City	Ground Type	Mean	SD	95% CI's	N
Hacienda Heights	Covered	3.6	1.8	(3.2, 4.0)	95
	Not Covered	4.8	2.1	(4.0, 5.6)	25
Missing Data		-	-	-	2
T-statistic = -2.9; p-value=0.005					
West Covina	Covered	3.3	1.7	(3.0, 3.6)	112
	Not Covered	5.5	2.7	(3.3, 7.7)	6
Missing Data		-	-	-	4
T-statistic = -2.9; p-value=0.004					

Table 18

Multiple Regression Models Predicting Log-Transformed Blood Lead Levels

MODEL 1:

Variable	Parameter Estimate	Standard Error	T-Statistic	P-Value
INTERCEPT	0.967388	0.19748203	4.899	0.0001
AGE	-0.003368	0.00160305	-2.101	0.0367
SEX	0.077590	0.05376744	1.443	0.1504
BACKYARD SOIL LEAD (log-transformed)	0.071087	0.04219902	1.685	0.0934
GROUND COVER	0.308343	0.08057464	3.827	0.0002

N=235*

* 9 children not included in these analyses due to missing information on backyard soil lead levels.

R^2=0.1154

MODEL 2:

Variable	Parameter Estimate	Standard Error	T-Statistic	P-Value
INTERCEPT	0.529817	0.28737814	1.844	0.0668
AGE	-0.002963	0.00176430	-1.679	0.0948
SEX	0.101990	0.05877839	1.735	0.0844
BACKYARD SOIL LEAD (log-transformed)	0.074788	0.04474424	1.671	0.0963
HOUSEDUST LEAD (log-transformed)	0.076767	0.04625640	1.660	0.0987
GROUND COVER	0.301349	0.08430455	3.575	0.0004

N=190*

* 54 children not included in this model due to missing data on housedust lead levels or backyard soil lead levels.

R^2=0.1489

Table 19

Pearson Correlation Coefficients, P-Values and Number of Children For Associations Between Blood Lead(Pb) Levels and Environmental Variables

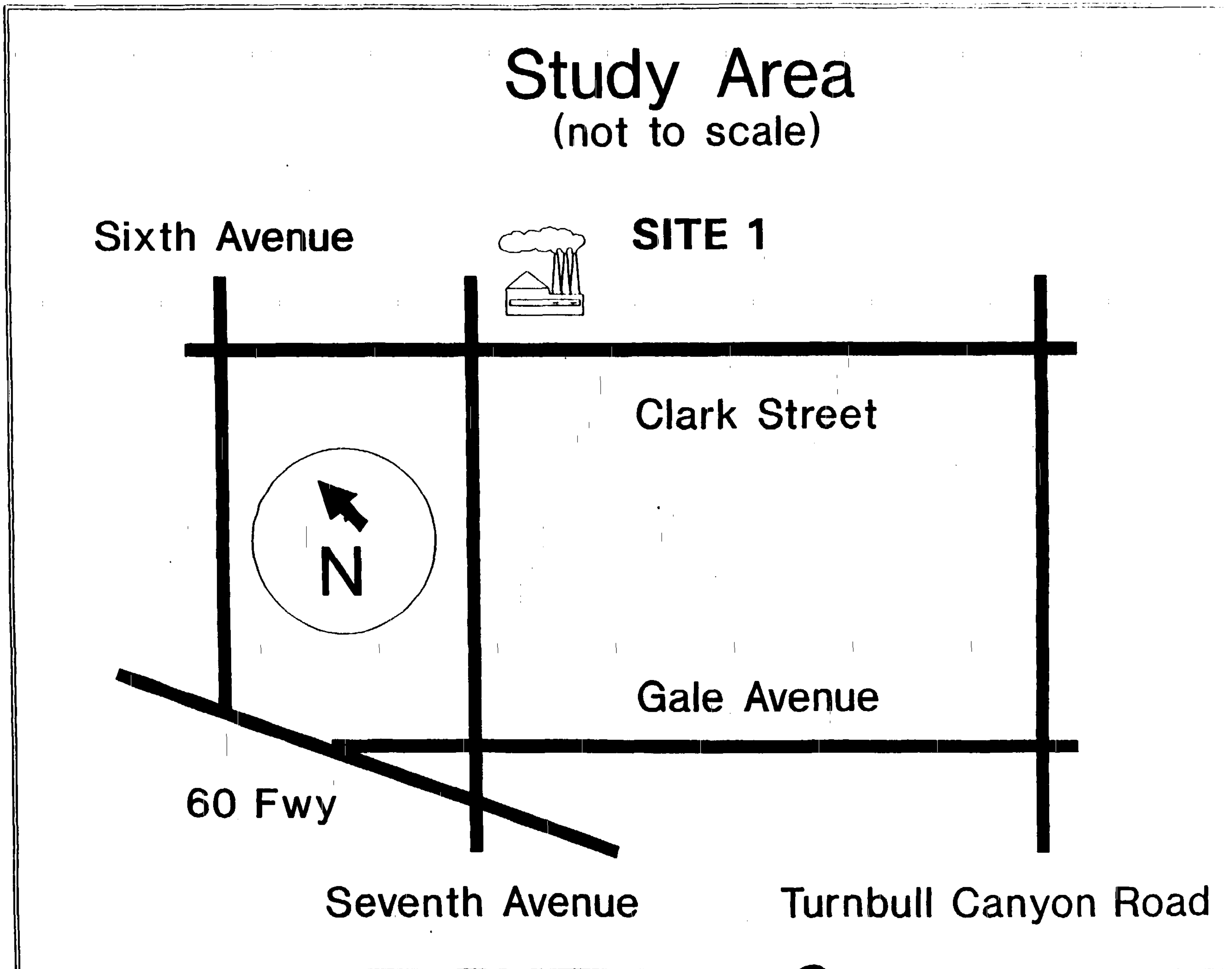
CC P-Value N	Blood Pb	Backyard Soil Pb	Frontyard Soil Pb	Path Soil Pb	Side of House Soil Pb
Blood Pb	1.00000	0.14954	0.08780	0.05114	0.11554
	0.0	0.0199	0.1716	0.4275	0.0728
	244	242	244	243	242
Backyard Soil Pb	0.14954	1.00000	0.17816	0.06419	0.44234
	0.0199	0.0	0.0054	0.3210	0.0001
	242	242	242	241	240
Frontyard Soil Pb	0.08780	0.17816	1.00000	0.29237	0.28200
	0.1716	0.0054	0.0	0.0001	0.0001
	244	242	244	243	242
Path Soil Pb	0.05114	0.06419	0.29237	1.00000	0.21337
	0.4275	0.3210	0.0001	0.0	0.0009
	243	241	243	243	241
Side of House Soil Pb	0.11554	0.44234	0.28200	0.21337	1.00000
	0.0728	0.0001	0.0001	0.0009	0.0
	242	240	242	241	242
Summary Soil Pb	0.11274	0.46738	0.82371	0.52312	0.38170
	0.0807	0.0001	0.0001	0.0001	0.0001
	241	241	241	241	239
Outdoor Paint Pb	0.07068	0.07172	0.15576	0.11987	0.24614
	0.2806	0.2756	0.0169	0.0672	0.0001
	235	233	235	234	233
Indoor Paint Pb	-0.02292	0.09049	0.23021	0.20476	0.21102
	0.7443	0.1980	0.0009	0.0033	0.0024
	205	204	205	204	204
Outdoor Air Pb	0.11215	-0.08338	-0.09734	0.07024	-0.28898
	0.2187	0.3652	0.2862	0.4439	0.0013
	122	120	122	121	121
Housedust Pb	0.17569	0.18552	0.10191	-0.04881	0.18928
	0.0133	0.0092	0.1531	0.4957	0.0079
	198	196	198	197	196

Table 19 (Continued)

Pearson Correlation Coefficients, P-Values and Number of Children For Associations Between Blood Lead(Pb) Levels and Environmental Variables

CC P-Value N	Summary Soil Pb	Outdoor Paint Pb	Indoor Paint Pb	Outdoor Air Pb	Housedust Lead
Blood Pb	0.11274 0.0807 241	0.07068 0.2806 235	-0.02292 0.7443 205	0.11215 0.2187 122	0.17569 0.0133 198
Backyard Soil Pb	0.46738 0.0001 241	0.07172 0.2756 233	0.09049 0.1980 204	-0.08338 0.3652 120	0.18552 0.0092 196
Frontyard Soil Pb	0.82371 0.0001 241	0.15576 0.0169 235	0.23021 0.0009 205	-0.09734 0.2862 122	0.10191 0.1531 198
Path Soil Pb	0.52312 0.0001 241	0.11987 0.0672 234	0.20476 0.0033 204	0.07024 0.4439 121	-0.04881 0.4957 197
Side of House Soil Pb	0.38170 0.0001 239	0.24614 0.0001 233	0.21102 0.0024 204	-0.28898 0.0013 121	0.18928 0.0079 196
Summary Soil Pb	1.00000 0.0 241	0.21010 0.0013 232	0.23333 0.0008 203	-0.04354 0.6382 119	0.10912 0.1289 195
Outdoor Paint Pb	0.21010 0.0013 232	1.00000 0.0 235	0.30087 0.0001 203	0.02392 0.7937 122	0.22649 0.0015 194
Indoor Paint Pb	0.23333 0.0008 203	0.30087 0.0001 203	1.00000 0.0 205	0.02491 0.7962 110	0.13877 0.0647 178
Outdoor Air Pb	-0.04354 0.6382 119	0.02392 0.7937 122	0.02491 0.7962 110	1.00000 0.0 122	-0.08921 0.3285 122
Housedust Pb	0.10912 0.1289 195	0.22649 0.0015 194	0.13877 0.0647 178	-0.08921 0.3285 122	1.00000 0.0 198

FIGURE 1

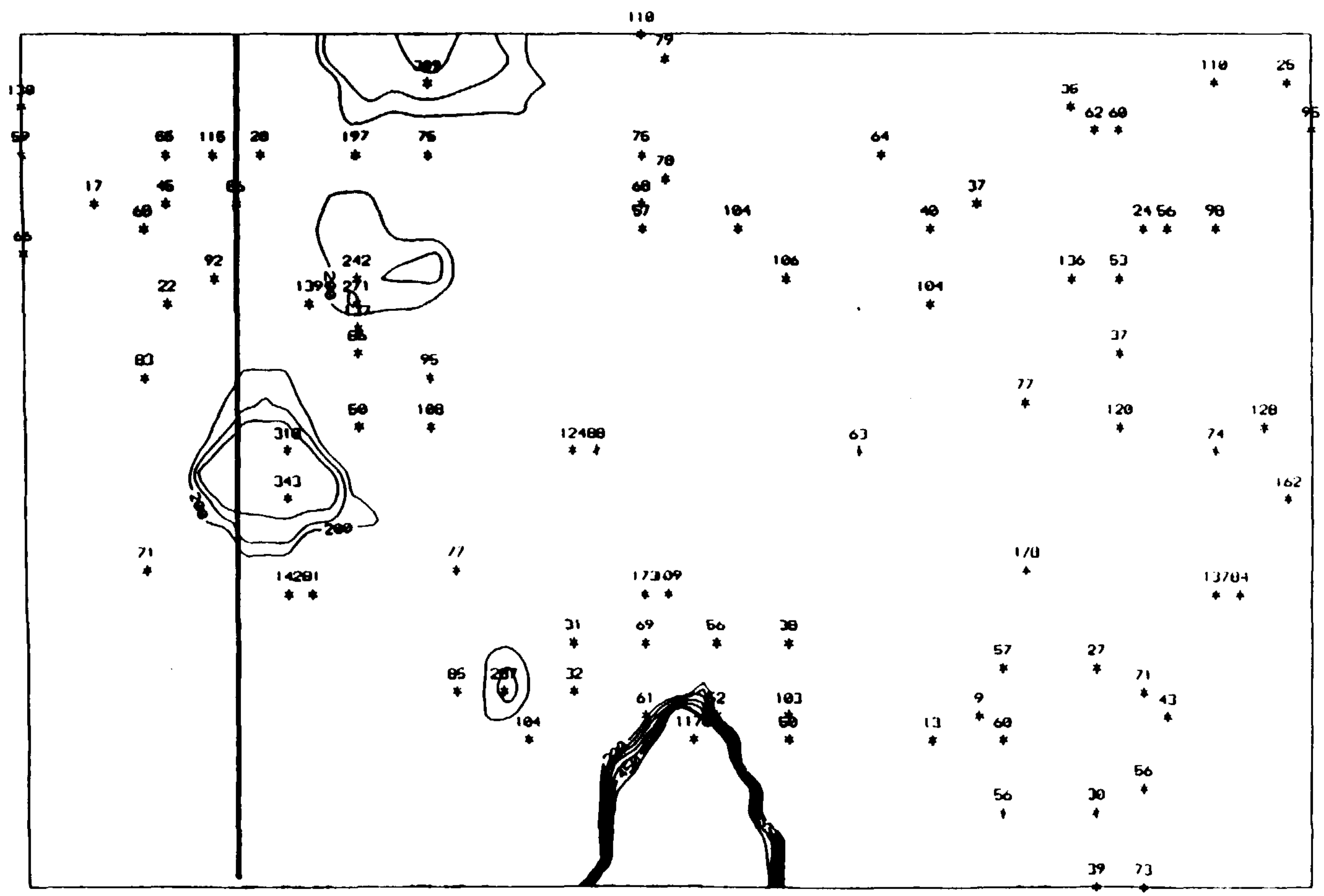


Study Area
(not to scale)
Sixth Avenue
SITE 1
Clark Street
N
Gale Avenue
60 Fwy
Seventh Avenue
Turnbull Canyon Road

FIGURE 2

Backyard Soil Lead Isopleths - 200 ppm

SITE 1

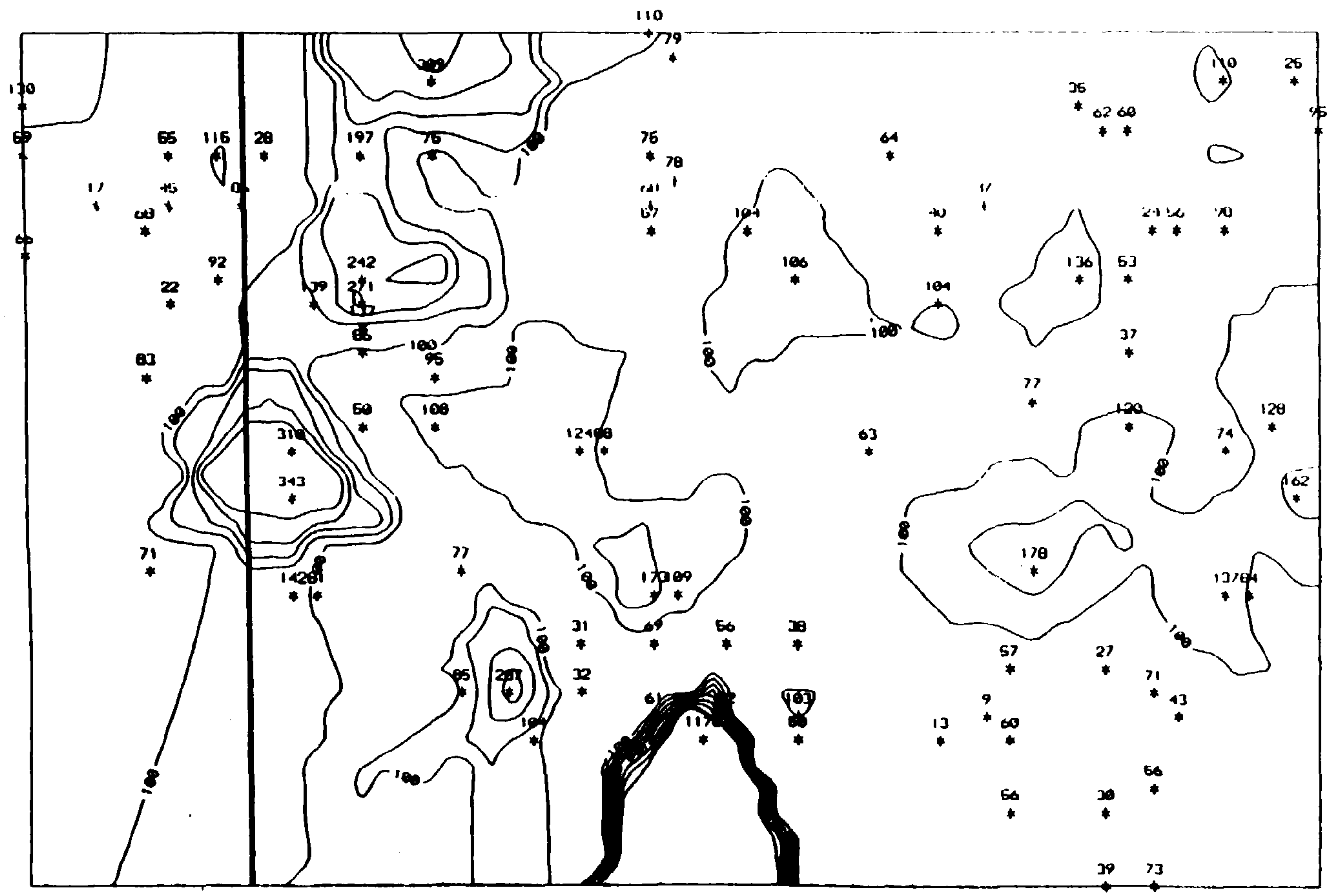


Seventh Avenue

FIGURE 3

Backyard Soil Lead Isopleths - 100 ppm

SITE 1



Seventh Avenue

Part II. Blood Lead Screening of Children Living Near Two Other Stationary Lead Sources

1. Summary

Blood lead screening was conducted for children ages 1 to 5 living near two additional stationary lead sources in Los Angeles County. The targeted lead sources were Site 2, a manufacturer of lead oxide in the City of Commerce; and Site 3, a battery manufacturer in the City of Industry. Site 2 is located adjacent to the community of Bell Gardens where 117 children who are residents of the area were screened. Site 3 is located adjacent to the community of La Puente, where 110 children, ages 1 to 5, were screened.

Of the 117 children screened in Bell Gardens who live near Site 2, the majority of the blood lead levels were under 10 ug/dl with two children with blood lead levels of 11 ug/dl. Of the 110 children who live in La Puente near Site 3, the majority of the blood lead levels were under 10 ug/dl also. However one child had a blood lead level of 15 ug/dl and another child had a blood lead level of 21 ug/dl. After further detailed investigation, it was determined that the lead exposures for the two children with elevated blood lead levels living in La Puente were unrelated to the stationary lead source.

2. INTRODUCTION

There are little data available concerning the impact of lead emissions from stationary sources in Los Angeles County on the blood lead levels of children living nearby. A modified version of the study described in Part I of this report was conducted at two additional sites in Los Angeles County. Blood lead screening only was conducted on children living near two stationary lead sources. Environmental testing was not conducted in the childrens' homes unless an elevated blood lead level was detected (greater than 15 ug/dl).

3. STUDY METHODS

Data on lead emissions, wind patterns and proximity to residential communities were evaluated in order to identify additional sites for blood lead screening. Site 2 was selected due to its close location on the south to the residential community of Bell Gardens. In addition, some elevated emissions were recently recorded to the north of the facility that faces an industrial area. Site 3, located adjacent to the community of La Puente, was selected due to its close proximity to a residential area and the large quantity of pounds processed at this facility per year.

The community surrounding each facility was leafleted with flyers describing the location and time that a mobile test van would be conducting blood lead screening for children ages 1 to 5. In addition, flyers concerning the blood lead screening were distributed to all the elementary and junior high schools in each of the two neighborhoods.

A mobile blood lead testing van was hired and placed at an elementary school in each of the two communities on a Friday afternoon/evening and Saturday morning/afternoon. Each screening session was 5 hours. While the families waited to obtain a blood lead test for their young children, a bilingual health educator conducted health education on the possible sources of lead in the home and outside environment. These sessions were conducted in both Spanish and English.

4. RESULTS

4.1 Blood Lead Levels

As shown in Table 19, the majority of the blood lead levels in both communities were less than 5 ug/dl, the limit of detection. In La Puente, there were two children with blood lead levels greater than or equal to 15 ug/dl.

The geometric mean of the blood lead measurements was 3.2 ug/dl in Bell Gardens and 3.7 ug/dl in La Puente (See Table 20). The geometric mean is the better measure of the central tendency of these data, as these data are not normally distributed.

4.2 Environmental Testing in Households With Children With Elevated Blood Lead Levels

Further testing was conducted for the two children living in La Puente living near Site 3 with blood lead levels greater than or equal to 15 ug/dl. One child had a blood lead level of 15 ug/dl and lived to the east of Site 3, approximately one-tenth of a mile. The child's backyard faced a busy street, Nelson Avenue, the street on which Site 3 is located. The child's backyard was mostly exposed dirt and had very little grass coverage. According to the child's mother, the child ate dirt in the backyard. Samples were taken of the outside soil, the indoor and outdoor housepaint and any imported pottery in the household. The indoor and outdoor housepaint samples had a fairly low lead content (average of 252 ppm and 249 ppm respectively) and the backyard outdoor soil sample also had a low concentration of lead (average of 86 ppm). There were two pieces of imported pottery in the home. One of the pieces tested positive for lead, however the child's mother indicated that the child did not eat food from this container. The lead source for this child was not positively identified, however the outdoor soil was ruled out as a source due to the low soil lead content.

A second child, living approximately one-half mile from the facility, had a blood lead level of 21 ug/dl. Paint, soil and pottery samples were obtained from this household. The paint lead levels inside and outside the home were somwhat high (average of 1380 ppm and 6110 ppm respectively). The outdoor soil lead levels were low (average of 128 ppm), however there was a Mexican bean pot identified in the home that was used every day for cooking. The child did not eat beans, however the mother of the child ate beans and was nursing the 15 month old child. It is believed that the child was exposed to lead through his mother's breast milk or from the interior or exterior housepaint in the home. It is unlikely that his lead exposure arose from the outside soil. Since these sources have been identified and stopped, the child's blood lead level has gone down to 10 ug/dl.

5. DISCUSSION

The blood lead levels of the sample of children, ages 1-5, living near Site 2 and Site 3 are within the range of normal. The two children with elevated lead levels living near Site 3 were both found to be unrelated to emissions from the Site 3 facility. From these data, it appears that the blood lead levels of the children living in these two communities are not adversely affected by the emissions from the stationary lead sources.

Table 20

Distribution of Blood Lead Levels (ug/dl) in Children in Bell Gardens and La Puente

	Bell Gardens		La Puente	
Blood Lead Level	**N**	**%**	**N**	**%**
<5 ug/dl	88	75	68	62
5-9 ug/dl	27	23	37	34
10-14 ug/dl	2	2	3	3
> 15 ug/dl	0	0	2	2

Table 21

Arithmetic and Geometric Means, Standard Deviations, and 95% Confidence Limits of Blood Lead Levels (ug/dl) in Bell Gardens and La Puente

	Bell Gardens	**La Puente**
Arithmetic Mean	3.5	4.3
Standard Deviation	1.9	2.9
95% Confidence Limits	(3.2, 3.8)	(3.8, 4.8)
N	117	110
Geometric Mean	3.2	3.7
Standard Deviation	2.7	2.7
95% Confidence Limits	(2.7, 3.7)	(3.2, 4.2)
N	117	110

III.

1. PROJECT ORGANIZATION AND RESPONSIBILITIES

1.1 U.S. Environmental Protection Agency - Region IX (EPA)

This study was made possible due to funding from the Region IX office of the EPA in San Francisco. EPA staff in the Air and Toxics Section in San Francisco were involved in securing additional funding for the project and consistently monitored the progress of the project.

1.2 South Coast Air Quality Management District (SCAQMD)

It was required by EPA that the funding used for this project be given to an air district. Thus, the SCAQMD actually received the funding from EPA and directed the project funds to the Los Angeles County Department of Health Services via the Public Health Foundation of Los Angeles County for purposes of this project.

The SCAQMD was integrally involved in the oversight of the project; the public outreach and information campaign; and the collection of the ambient air samples. SCAQMD staff monitored the project objectives and were responsible for securing additional funding for the project. District staff helped to organize the public meetings that were held throughout the duration of the project and were responsible for locating the ambient air monitors and conducted data collection and analysis of air samples.

1.3 Los Angeles County Department of Health Services (LACDHS)

The Toxics Epidemiology Program (TEP) within LACDHS conducted the project by providing the services of the Principal Investigator and the office space for the project. LACDHS was able to hire temporary personnel for the project through the Public Health Foundation of Los Angeles County. The Principal Investigator and the project staff were responsible for designing the project, collecting the data and performing data analysis.

1.4 California Department of Health Services (DHS)

The Childhood Lead Poisoning Prevention Program (CLPPP) in the DHS was responsible for funding the analysis of lead in the blood of the children participating in the project through the Environmental Health Laboratory (EHL) in Berkeley, California. In addition, EHL prepared the samples for dust collection and conducted the analysis of lead in the housedust. The CLPPP also lent considerable expertise to review of the study protocol and the training of study personnel in environmental sample collection techniques. CLPPP provided the study staff with vacuum cleaners outfitted with a special dust collection mechanism that allowed for quantification of lead in the housedust.

References

1. Benevich, Teri., "New Sources Add to Lead Poisoning Concerns", Journal of the American Medical Association, vol. 263, no. 6., pp. 790-791, Feburary, 1990.

2. California Department of Health Services, Childhood Lead Poisoning Prevention Program, 'Lead in Soil', July, 1991.

3. California EPA, Department of Toxic Substances, "Off-Site Sampling Summary, Quemetco, Inc., December 6, 20, 23, 1991".

4. Centers for Disease Control, U.S. Department of Health and Human Services, 'Preventing Lead Poisoning in Young Children', October, 1991.

5. Cook, Magdalena., Chappell, Willard R., Hoffman, Richard E., Mangione, Ellen J., "Assessment of Blood Lead Levels in Children Living in a Historic Mining and Smelting Community", American Journal of Epidemiology, vol. 137., no. 4., 1993, pp.446-55.

6. Doe, J.B. Batteries, Secondary, in Kirk-Othmer, Encyclopedia of Chemical Technology, Third Edition, Volume 3. New York: Wiley-Interscience Publication; 1978.

7. Landrigan, Philip J., Gehlbach, Stephen H., Rosenblaum, Bernard F., Shoults, Jimmie M., Candelaria, Robert M., Barthel, William F., Liddle, John A., Smrek, Ann L., Staehling, Norman W., Sanders, DoDean., "Epidemic Lead Absorption Near an Ore Smelter: The Role of Particulate Lead", New England Journal of Medicine, vol. 292., no. 3., pp. 123-129., 1975.

8. Levallois, Patrick., Lavoie, Michel., Goulet, Lise., Nantel, Albert J., Gingras, Suzanne., "Blood Lead Levels in Children and Pregnant Women Living Near a Lead Reclamation Plant"., Canadian Medical Association Journal, vol. 144., no. 7., pp. 877-885., 1991.

9. Lin-Fu, Jane S., "Undue Absorption of Lead Among Children- A New Look at an Old Problem", New England Journal of Medicine, pp. 702-710, 1972.

10. Roberts., T. M., Hutchinson, T.C., Paciga, J., Chattopadhyay, A., Jervis, R.E., Vanloon., J., "Lead Contamination Around Secondary Smelters: Estimation of Dispersal and Accumulation by Humans", Science., vol. 186., pp. 1120-1123, December, 1974.

11. Roels, Harry A., Buchet, Jean-Pierre., Lauwerys, Robert R., Braux, Pierre., Claeys-Thoreay, Francoise., LaFontaine, Alphonse., Verduyn, Geert, "Exposure to Lead By the Oral and the Pulmonary Routes of Children Living in the Vicinity of a Primary Lead Smelter', Environmental Research, vol. 22, pp. 81-94, 1980.

12. Statistical Analysis Systems, Version 6.02, Raleigh, North Carolina.

13. South Coast Air Quality Management District Memo from Ed Camarena to James Lents, "Exceedance of Federal and State Lead Standards", December 4, 1991.

14. U.S. Department of Commerce, Bureau of the Census, Los Angeles Couty Department of Regional Planning, Affiliate Census Data Center, Los Angeles County, 1990 Census of Population By Racial Group and Hispanics, by Census Tract.

15. U.S. Department of Commerce, Bureau of the Census, 1990 Census of Population and Housing, Summary Tape File 3 on CD Rom.

16. Yankel, Anthony J., von Linden, Ian H., Walter, Stephen D., "The Silver Valley Lead Study: The Relationship Between Childhood Blood Lead Levels and Environmental Exposure", Journal of the Air Pollution Control Association, vol. 27, no. 8., pp. 763-767, August, 1977.

APPENDIX A

PROCEDURES FOR COLLECTION OF VENOUS BLOOD SAMPLE

The procedure for drawing blood was first explained in detail to the parent and the child by the nurse/certified phlebotomist. The parent or guardian was asked to sign the consent form. The child's arms and hands were inspected and the best site for venipuncture was selected. The child lay down on a couch with the arm for venipuncture closest to the nurse. The parent or guardian sat with the child's head in his or her lap. The parent was instructed on how to hold the child's shoulders and arms so that the child was immobilized. A pair of disposable gloves was worn by the nurse/certified phlebotomist. A tourniquet was placed on the child's arm. The venipuncture site was thoroughly cleaned with an alcohol swab. The site was dryed with gauze. The needle was inserted into the selected vein. When blood entered the tubing, the 3 ml syringe was immediately screwed into the end of the tubing. The syringe was slowly drawn back until 3 ml's of blood were collected. The needle was gently pulled out. The gauze pad was placed over the venipuncture site and pressure was applied. The parent continued to apply pressure to the site with the gauze. The 1 purple-top tube of blood was labeled with the household identification number, the child identification number, the name of the child, the child's date of birth, date of sampling, time and initials. The blood in the purple-top tube was placed in the stryofoam ice-chest and kept cool and out of the light. The venipuncture site was inspected to insure that the child had stopped bleeding. A bandaid was placed over the site and the child was given a toy. The contaminated materials were placed in the red puncture-resistant hazardous waste container for proper hazardous waste disposal. The blood samples were packaged according to Department of Transportation regulations for shipping blood products and were mailed to the Environmental Health Laboratory (EHL) in Berkeley every two days for analysis for lead. The blood was stored in a refrigerator at the study headquarters until shipment to Berkeley.

APPENDIX B

PROCEDURES FOR COLLECTION OF SOIL SAMPLES

The environmental health technician (EHT) was responsible for collecting four composited soil samples around each home. One composited sample was collected from the front yard; a second composited sample was collected from the area around the path that leads to the primary entrance of a home; a third composited sample was collected from the rear yard of the home; and a fourth composited sample was collected from an area in close proximity to the home.

B.1 Instructions for Selection of Soil Sample Locations

a. Front Yard of House

The goal of this sample was to obtain soil samples that are representative of the area in the front yard in which a child plays. The EHT divided the portion of the front yard that is at least six feet from the house into two rectangles on either side of the path to the front door. The EHT drew an imaginary line across the middle of the two rectangles and took four equally-spaced composite samples from each of the two rectangles for a total of eight composite points. This front yard sample excluded soil samples from the area next to the path to the main entrance in the home.

b. Path To House

The EHT drew an imaginary rectangle around the path to the primary entrance to the home that is at least six feet from the house. The EHT obtained four composite soil samples from the area around the path or in the four corners of the rectangle that surround the path. If there was no actual paved or gravel path to the main entrance of the home, soil samples were taken around the dirt area that serves as the path to the home.

b. Rear of House

The EHT divided the portion of the rear yard that is at least six feet from the house into a rectangle and sampled four points along the center line of the rectangle which comprised one composited sample.

c. Side of House

The site for the side yard sample was taken from the left side of the house while facing the house from the street. For houses where there was no area with soil to the left of the house, a sample was taken from the right side of the house. The EHT estimated the approximate center of the side of the house and drew a circle 2 feet in diameter as close as possible to the foundation of the house. A sample was taken on the perimeter of the circle close to the foundation; two samples were be taken 1 foot from the foundation on the sampling circle; and a fourth sample was taken two full feet from the foundation, also on the sampling circle.

B.2 Instructions for the Collection of Soil Samples

The soil sampling locations was determined as described above (B.1 Instruction for Selection of Soil Sample Locations). The EHT selected the sampling sites. Each soil sample was collected using a new plastic scoop from each of the sites along the rectangles and the circle. Each sample was collected from the top 1 inch of the soil. Grass or growing plants were cut off to 1/4 inch above the soil. The EHT did not alter the surface of the soil prior to sampling. It is particularly important that the EHT did not discard organic matter or a surface mat of decayed grass or leaves, as lead is adsorbed more strongly on organic matter than on organic soil. Each sample was placed in a whirlpak. Each sample was generous in size (approximately 50 grams) and the total composited sample filled the whirlpak approximately one-third of the way full.

The whirlpak was labeled with the household identification number, the location of the sample, the date, and the initials of the EHT. The plastic scoop was discarded after the collection of each composited sample and a new plastic scoop was used for each sample.

Five percent of the composited soil samples had a co-located sample collected to assess sampling variability. For each quality control sample, a second sample was obtained in close proximity to each of the four points on the sampling rectangles or circle. The analysis of lead in these two co-located soil samples was similar and was submitted as separate samples to the lab and served as a quality control check for sampling variability. The lab also conducted analysis of split samples to assess variability in the analytical method. The EHT delivered the soil samples to the contract laboratory for analysis of lead on a weekly basis. At each home in the exposed neighborhood, the soil sample that was closest to the secondary lead smelter was also analyzed for other metals in addition to lead that was emitted from the facility. This included arsenic, antimony, cadmium, and copper. In the control neighborhood, one soil sample of the three collected from the perimeter of the home was randomly selected and also analyzed for other metals for purposes of comparison to the soil metal analyses from the community near the stationary lead source.

APPENDIX C

PROCEDURES FOR COLLECTION OF DUST SAMPLES

Dust samples were taken after all of the children had their blood drawn to avoid contamination of the blood samples. Dust samples were collected using a 3 horse power vacuum with an attached filter cassette which was modified to hold a filter. The parent was asked to identify the child's major play area. Sample collection took place in the center of a room and at least 1.5 feet from the walls or passageways. Bare floors and rugs were not sampled together. If a child played in an area with both a bare floor and rug, the rug was sampled as a child is more likely to play on a rug than a floor due to comfort. An area that was a minimum of 3 square meters and a maximum of 6 square meters was identified. For every square meter of space, the EHT vacuumed for two minutes. Different-sized square templates were available to the EHT to delineate the portion of the floor to be vacuumed.

All surfaces of the template and forceps were thoroughly cleaned by spraying with alcohol and wiping with paper towels before sampling.

One filter and two 2x2 gauze pads were weighed before and after sampling and placed in a petri dish. The filter collected the dust and the 2x2 gauze pads was moistened with alcohol and used to wipe out the filter holder after sampling to remove the dust which adhered to the walls of the cassette.

Wearing disposable gloves, the forceps were used to place a filter carefully into the cassette holder. The filter was not touched other than on its edge. The lid was placed back on the petri dish that held the filter and gauze pads.

The vacuum was turned on and the timer on the vacuum was set to the proper number of minutes. The EHT systematically vacuumed the area within the identified area. At the end of vacuuming, the vacuum was turned off and the EHT changed to a clean pair of gloves. The lid was removed from the petri dish. The filter was carefully removed from the filter cassette with the forceps so that no dust fell off the filter. The filter was placed in the petri dish. The EHT sprayed the inside of the cassette holder with alcohol. Using forceps to hold